EDGES MEMO #511

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To: EDGES group

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Subject: The estimated electron temperature in the ionosphere from calibrated EDGES-3 data

An estimate of the expected contribution of electron temperature in the ionosphere was made in memo 79 in 2011 and the observed effects on EDGES data from were made from days 108 to 113 of 2014 at GHA = 14 hours documented in memo 143. Memo 139 incorporates the effect of the ionosphere on the sky temperature into additive and multiplicative terms.

Observations acquired at the Murchison Radio-astronomy Observatory in Western Australia from 18 April 2014 to 6 May 2014. Show perturbations that increase at sunrise, continue during the day, and decline after sunset. Magnitudes corresponding to an opacity perturbation of about 1% at 150 MHz with a typical electron temperature of about 800 K were measured for the strongest perturbations.

These results are published in:

Rogers, A.E.E., Bowman, J.D., Vierinen, J., Monsalve, R. and Mozdzen, T. (2015). Radiometric measurements of electron temperature and opacity of ionospheric perturbations. *Radio Sci.*, 50, 130–137. https://doi.org/10.1002/2014RS005599

The effects of a high electron temperature on the spectral index of the sky noise are studied in the EDGES-3 data from Devon Island in memo 420 and used to explain the “RFI”. However the drop of the sky noise spectral index which is expected from high electron could not be distinguished from power line noise via sporadic E, or “plasma patches”.

The EDGES-3 c-code and c-shell scripts using “longav” estimate the ionosphere absorption and emission based on the deviation from a “reference” spectral index of 2.55 in the function “fition” but the code for the plots made for EDGES-2 in the reference above have not been updated for EDGES-3.

Some results from the MRO are listed in the table using data from EDGES-3 below:

data	GHA hours	T 75 MHz	spec_index	Ion percent	T electron K
2024:084:14:50	17	2157	-8.94	97.9	2197
2024:094:14:10	17	2156	-7.18	71.2	2886
2025:101:17:38	21	3662	-8.52	107.4	3444
2025:101:18:54	22	4337	-3.16	16.6	11152
2026:014:19:22	17	2151	-2.80	5.03	10074
2026:034:17:59	17	2132	-3.39	13.2	8993
2026:044:17:24	17	2147	-3.06	8.8	10014
2026:054:16:45	17	2149	-3.86	19.57	7460
2026:064:16:05	17	2148	-2.75	4.51	9362
2026:074:15:26	17	2149	-3.31	12.3	9357

2026:084:14:50	17	2159	-5.47	44.6	4201
2026:094:14:08	17	2142	-5.14	36.4	4965
2026:104:13:35	17	2168	-3.06	8.3	10962
2026:135:11:30	17	2151	-2.77	4.15	11465

Table 1. Selected times of high Electron temperature with sun more than 20 degrees below the horizon
Table 1 shows the electron temperature which is estimated using:

acqplot parameters:
-dgha 0.5 for 1 hour blocks of GHA
-rfi 2.1
-maxrmsf 200
-maxfm 2000
- sunlim -20
-smooth 8
longav parameters:
-lim 3
-nfit 4
-fstart 60
-fstop 102
-sig 0
antenna beam: azelq_box_perf_48_2e-2
calibration: specals_210opt.txt
antenna s11: s11ant070.csv

The choice of data for 2024 and 2025 is based only finding a limited range of times with strong emission while strong emission is found for all days in 2026. All the results in Table 1 were run with longav covering 60 to 102 MHz. Table 2 shows that the effect of noise can be reduced with the wider frequency range.

data	GHA hours	T 75 MHz	spec_index	Ion percent	T electron K
2026:094:14:08	17 50-102	2142	-4.26	24.68	6528
2026:095:14:04	17 50-102	2145	-3.93	20.01	7454
2026:096:13:58	17 50-102	2137	-3.98	20.71	7298
2026:094:14:08	17 60-102	2142	-5.13	36.46	4965
2026:095:14:04	17 60-102	2145	-4.21	23.77	6705
2026:096:13:58	17 60-102	2137	-3.91	19.73	7512

Table 2. Comparison of the results using longav frequency range 50 -102 and 60 - 102 MHz

Table 3 shows the reduction in noise for time span without an elevated electron temperature which shows that the noise produces a negative value for the electron temperature which gets reduced when the wider bandwidth of 50 – 102 MHz is used.

data	GHA hours	T 75 MHz	spec_index	Ion percent	T electron K
2025:084:14:46	17 50-102	2147	4.864	-103.67	-2619
2025:085:14:42	17 50-102	2148	50.15	-756.33	-325
2025:086:14:38	17 50-102	2146	9.92	-178.91	-1449
2025:084:14:46	17 60-102	2147	0.466	-40.74	-8132
2025:085:14:42	17 60-102	2148	0.827	-46.18	-6921
2025:086:14:38	17 60-102	2146	0.674	-44.40	-7323

Table 3. Comparison for time span without elevated electron temperature